KNOWLEDGE

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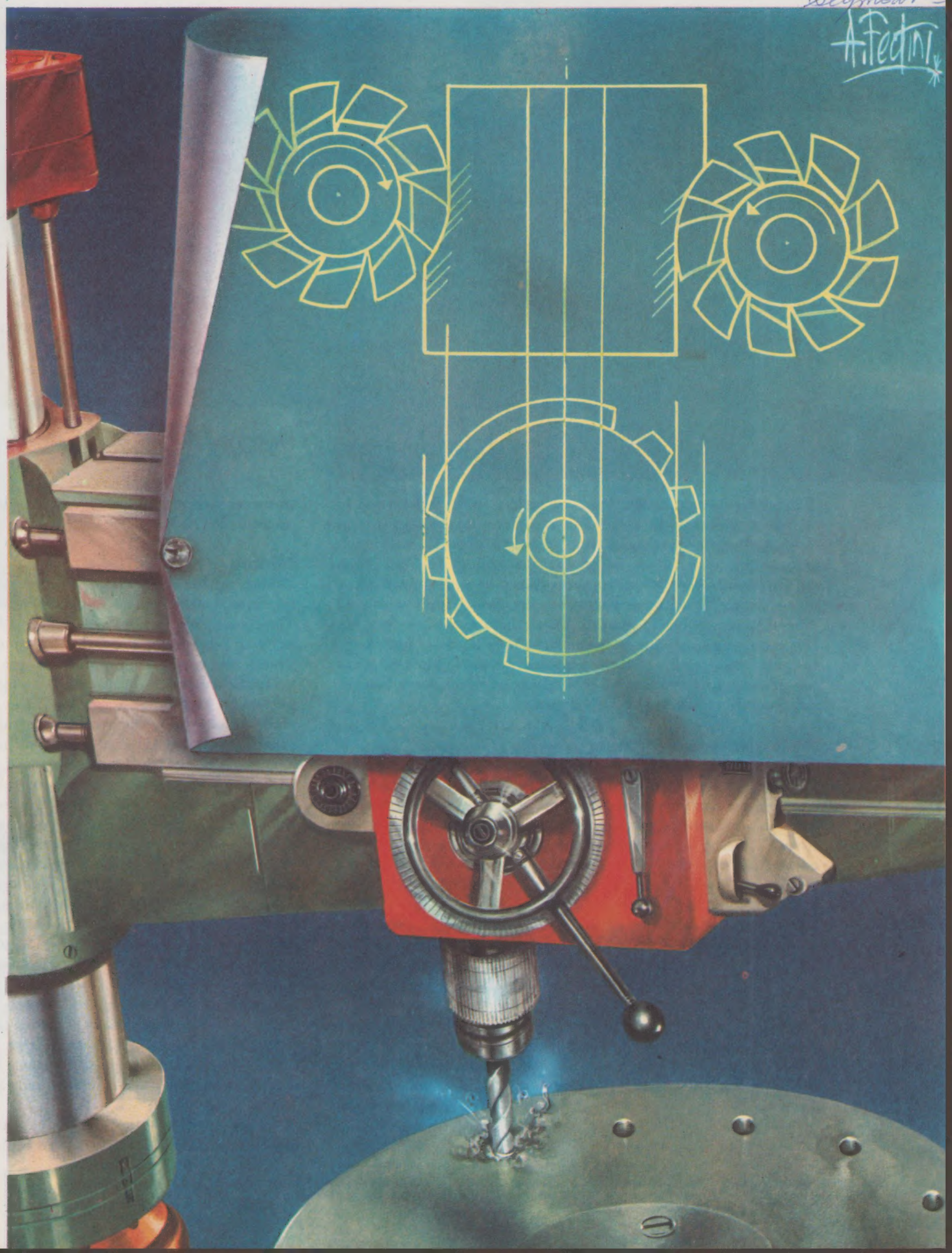

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1 INDUSTRY

One of the giant oil-refining works of the Shell Refining Company – oil is one of today's basic industries

IT needs a book rather than an article to do full justice to industry. A cow in a field, an aeroplane in the sky, in fact much that you see around you, is either a part or a result of industry. Yet if we make the distinction between basic industry and other industry the subject becomes much more manageable. These basic industries are those from which all others have evolved, and all began before this century. In this article we are going to look at the bare bones of industry – the skeleton around which the vast and complex industrial giant has grown – and at some of the industries which have become indispensable to us in the 20th century.

Agriculture and farming

The most basic industry is agriculture and farming, which supplies us with food and with many of the materials used to make clothing. In the most primitive societies, men live by hunting wild animals which provide meat, and skins for clothing and shoes. Then, at a more advanced stage of development, agriculture begins – usually as the cultivation of wild grasses and grain crops such as maize, barley, and wheat. The next stage, husbandry, is the rearing of animals for their milk, meat, wool, and skins. Countries such as Australia and New Zealand earn their living in the world by rearing many millions of sheep, and base most of their export trade on exporting their wool and meat to more densely populated countries like Britain.

Agriculture and farming today is a highly developed business in which chemical fertilisers and a wide range of complicated machinery are used. British agriculture is among the most highly mechanised in the world, and British farmers are among the most efficient and productive. One important reason for this efficiency is that the market prices of their crops and animals are guaranteed by the government, in order to ensure a regular output from the farmers, and relatively stable prices in the shops.

Mining

Mining is the extraction from the earth of the many vitally important mineral materials which we need for civilised life. These materials include coal, clay, and the ores of metals such as iron, aluminium, nickel, chromium, tin, and copper, on which the engineering industries are based. Another highly valuable mineral is uranium ore, which is used in generating nuclear power. Broadly speaking, the mining industry also includes quarrying, which is the extraction from the earth of granite and other types of stone used in building.

In Britain coal is by far the most important mineral, and the coalmining industry is one of the largest in the country. Since 1946 the coal industry of Britain has been *nationalised* – that is to say, it is the property of the government and people of the country – and it is controlled by the National Coal Board. The story of coal is very largely the story of the growth of modern industry in Great Britain, Western Europe, and America. Before 1700 coal was little used in Britain, and then only near the mines, and in London. Lack of transport facilities prevented its use elsewhere. But with the invention of coke-smelting and the steam engine the demand for coal greatly increased. Steam power also made possible the technical development of industry, and it was soon used for pumping the water from coal mines, driving the machinery for lifting the coal out of the mines, and later for colliery locomotives. As the 19th century progressed many factories installed steam-driven machinery, and the first railways and steamships were built.

Today open coal fires are dying out, as they are inefficient and create too much smoke, but coal is used more and more in

Previous page: Machine tools are at the very heart of industrial production. (*Above*) a diagram of a machine for cutting cog wheels; (*below*) a rotating drill for boring holes.

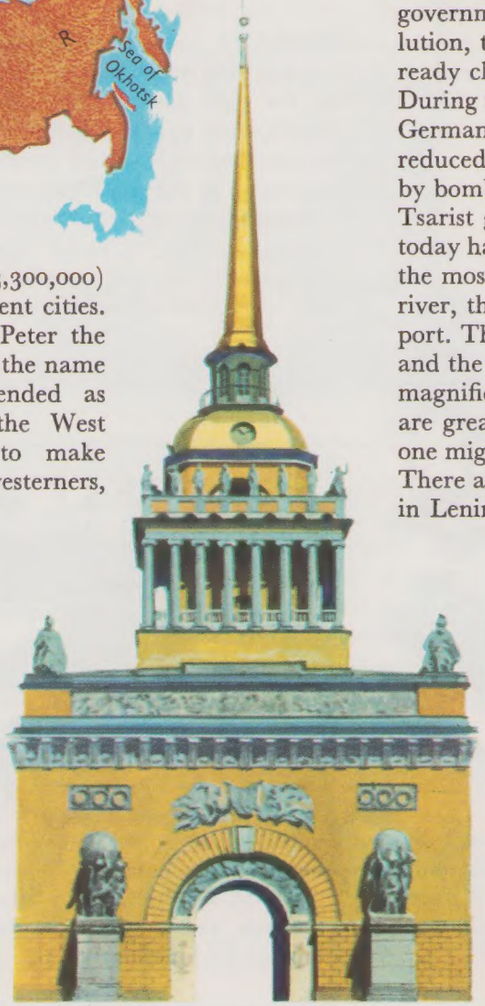
U S S R – cities

The famous cathedral of St Isaac, built in 1817; one of the many western-style buildings which dominate Leningrad

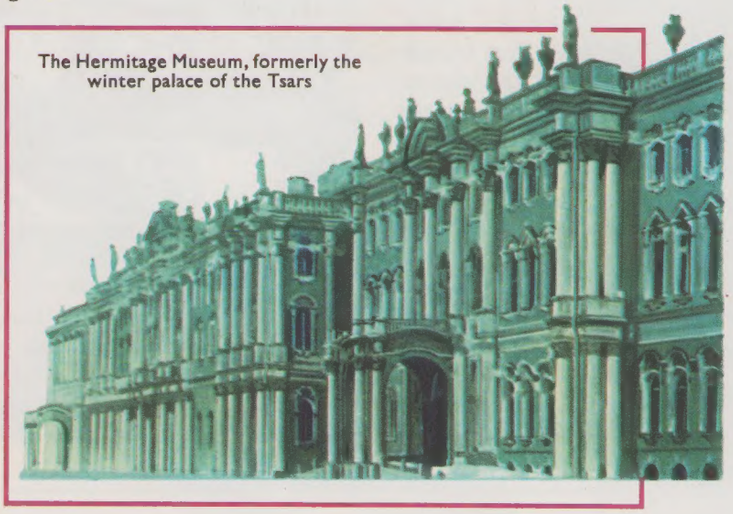
SVERDLOVSK, Donetsk, Tbilisi, Chelyabinsk . . . the likelihood is that you know little about these cities or possibly have never heard of them. However, all of them are bigger than many great European cities that you undoubtedly have heard of – cities like Marseilles, Manchester, and Hanover.

In fact, there are many colossal cities in the U S S R which are not known to the outsider. Why? Simply because they have grown up so swiftly. Before 1917 Russia was a largely agricultural country. It had three great and important cities: Moscow (see page 1764), St Petersburg, and Kiev, all in the west. But since 1917 there has been a great drive to industrialise the country, and the result of this has been the rapid growth of industrial cities in the centre of Russia – cities like the Siberian metropolis, Novosibirsk, or oil towns like Baku. Many of these new cities are, by our standards, ugly, as they are dominated by heavy, pretentious public buildings or drab functional blocks of flats. Yet they testify to the tremendous economic achievements of the U S S R since the Revolution.

LENINGRAD (population 3,300,000) is the newest of Russia's ancient cities. It was founded in 1703 by Peter the Great (see page 2172), under the name St Petersburg. It was intended as an outlet for trade with the West through the Baltic, and to make Russia more accessible to westerners, for Peter was a very western-minded Tsar. In 1712 it became Russia's capital. Despite contemptuous remarks by Voltaire ('designed as a lair of wolves and bears rather than a dwelling of men'), the city grew rapidly apace with Russian greatness. Much that was magnificent in the architecture of the period was used to glorify it. Great streets like the Nevski Prospekt (2½ miles long), churches, and palaces were built. It continued as the seat of Russia's government right up to 1918, when, after the Bolshevik Revolution, the capital was moved to Moscow. In 1924 the name (already changed to Petrograd in 1914) was changed to Leningrad. During the Second World War Leningrad withstood a siege by the Germans which lasted for nearly three years. The inhabitants were reduced to near starvation, yet, although great damage was done by bombs and shells, they did not yield. Many of the relics of the Tsarist grandeur are still much in evidence, although Leningrad today has a rather down-at-heel appearance. However, it is one of the most important industrial cities of the U S S R, and when its river, the Neva, is not covered by ice, it is a busy and important port. There are canals connecting Leningrad with the White Sea and the Volga river. The Hermitage Museum is in Leningrad; its magnificent art gallery has some very fine paintings. Many of these are great works of European art collected by the Tsars – in fact, one might call the Hermitage 'Russia's window on Western art'. There are also several branches of the Soviet Academy of Science in Leningrad.



The magnificent 19th-century Admiralty building, Leningrad

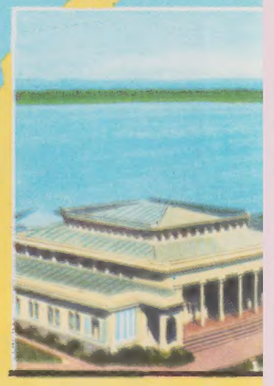


The Hermitage Museum, formerly the winter palace of the Tsars

KIEV (population 1,102,000) was in the Middle Ages something of a legend, as tales of its 400 churches with their domes flashing in the sun came back to Europe. It was the capital of the Grand Duchy of Kiev, set up by the Vikings. Today few of the golden domes are left, although the 11th-century cathedral of Sancta Sophia is still there with some of its splendour intact. Most of the ancient city has been destroyed, either in the 1917 Revolution or during the Second World War. Even though it has been largely rebuilt, Kiev today is a beautiful city with its wide, tree-lined streets and the great river Dnieper which flows through it. After visiting Moscow and Leningrad the traveller often notices a more exuberant air about the Kievites. They laugh more and are better dressed. Kiev has the reputation of being one of the most prosperous cities in the U S S R. Kiev is the capital of the Ukraine Republic, and also its cultural centre. After Kharkov it is the most important industrial city in the Ukraine.

The river Dnieper swirls through the green countryside surrounding Kiev

Kharkov: the *Bia ga Viescienska*, an old church with spectacular pink and white stripes



KHARKOV (population 930,000) is the second city of the Ukraine, and might be described as its industrial capital. It lies on the right bank of the Upper Donets river, and owes its development to the industrialisation of the South Ukraine and to the Donets coalfield nearby. The city is appropriately dominated by the great Palace of Industry.

But Kharkov is not just an industrial centre and important railway junction; it has a university, founded in 1805, and artistic, historical, and agricultural museums. It is a well-planned city, with broad streets, fine squares, and pleasant gardens.

ODESSA (population 667,000), in the Ukraine, is one of the chief Russian ports. It has five harbours and is a great trading centre. There is an active ship-building industry. The population is extremely mixed and includes Great Russians, Ukrainians, Jews, Germans, Greeks, Armenians, Tatars, and Turks. The harbours freeze for a few days in each year, but the climate is milder than in the rest of the Ukraine. In summer the city is very hot, but the broad avenues of the town are shaded by trees. There are numerous health resorts around Odessa, for many of the silted-up river mouths contain beneficial salt solutions.

The docks at Odessa, Russia's port on the Black Sea

Salt production is one of Odessa's most important industries, but these also include glass-, metal-, and brickwork, and machine manufacture. There is also an aeroplane factory.

A panoramic view of Baku, Russia's great oil town

BAKU, on the Caspian Sea, is the fourth largest town in Russia, and capital of the Azerbaijan Republic. It is famous as an oil-producing centre, and grew rapidly after the de-

GORKIY (population 942,000), situated at the confluence of the Oka and Volga rivers, is an important centre of industry and of communications. The city was originally known as Nijni-Novgorod, but in 1932 it was renamed after the Russian writer Maxim Gorkiy, who was born there in 1868. Until 1930, annual fairs used to be held at Nijni-Novgorod at which merchants from the Moscow region to the west would exchange goods with those from the east. The town has three parts. The old, or upper, city on the high right bank of the river Oka, with its Kremlin, or ancient citadel, is the site of two 13th-century cathedrals and the university. The industrial section stands on the low-lying left bank of the Oka, including the giant Molotov automobile plant, one of the largest in Europe. More factories are clustered on the right bank of the Volga, making machinery and processing foodstuffs.

Gorkiy – heavy traffic on the Volga, which flows through it

KUYBYSHEV (population 806,000) lies on the river Volga, at the mouth of the river Samara. Founded in 1586, it was originally named Samara, and became important with the building of the Trans-Siberian railway. It was renamed Kuybyshev in 1935 after the Russian leader. In 1939 its population was 390,267, but it grew enormously in the Second World War, when embassies and government offices were transferred there for a time from Moscow.

Kuybyshev is an industrial town, with a hydroelectric power station, nearby oilfields, and industries including heavy engineering. It is a market and port for the surrounding grain area.

The river front at Kuybyshev, another of the great Volga ports

VOLGOGRAD (population 591,000) was known until recently as Stalingrad. It lies on the river Volga, at its nearest point to the river Don, to which it is linked by railway. It is an industrial centre, manufacturing metal goods, machinery, chemicals, confectionery, beer, and tractors, and has sawmills and naphtha-refining works.

Much of the city has been rebuilt since the Second World War, when it was the scene of fierce fighting and was severely damaged. It was attacked by the Germans in August 1942, but the Russians defended it strongly and forced the Germans to capitulate in February 1943. This was, in fact, a turning point in this phase of the war.

NOVOSIBIRSK (population 887,000), on the river Ob, is the largest and most important city in Siberia today, although it was founded less than a century ago. Novosibirsk was begun in 1893, during the construction of the great Trans-Siberian railway on which it stands. The railway brought people and industries to Siberia, and Novosibirsk's rapid growth soon gave it the nickname of the 'Chicago of Siberia'.

The town is well laid out, with large ferro-concrete buildings, broad parks, and spacious gardens. It is an important machine-manufacturing centre, producing Russia's much-needed tractors and mining equipment. Other industries are ship-building, brick-making, distilling, and plastics.

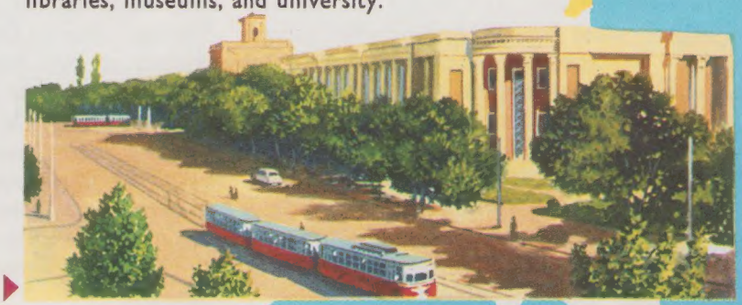
The centre of Novosibirsk: 'the Chicago of Siberia'

velopment of the oil-refining industry in the 1870s. Today its population is 968,000. It also has flourishing machine-manufacturing, chemical, textile, and food industries.

Baku is a great educational centre; it is the seat of the Azerbaijan State University, and also has industrial, economic, medical, and scientific institutes, and State opera and ballet companies. The old quarter of the city has many fascinating monuments, including the 12th-century Maiden's Tower and the 15th-century Khan's Palace.

TASHKENT (population 911,000) is the capital of the Uzbekistan Republic, the economic centre of Soviet central Asia. It lies in the chief cotton-growing area of the USSR, and is a flourishing industrial and railway centre. Power comes from the nearby hydroelectric power station at Chirchik, and major industries include iron and steel, and the manufacture of textiles, mining equipment, and agricultural machinery.

Tashkent is one of the oldest central Asian cities, and dates back at least as far as the 7th century A D, when it was an Arab town on the great trade routes. Today it has two parts: the old oriental quarter, with narrow streets, buildings of mud bricks, mosques, and bazaars; and the modern Soviet city, with its factories, fine official buildings, libraries, museums, and university.



Tashkent, one of the oldest cities in central Asia

THE ENGLISH MEDIAEVAL WOOL TRADE

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FOR 400 years, from the 12th to the 15th centuries, wool was the most important English product. So much so, that the Lord Chancellor himself sat enthroned on a woolsack, royal ransoms were paid out of wool, and the country's wars were financed by wool merchants. Many families which were to be among the most powerful in the land, like the de la Poles and Pultneys, began as wool merchants; and some of the loveliest mediaeval churches and houses were built by woolmen, like the one who engraved on the windows of his new house:

'I praise God and ever shall
It is the sheep hath paid for all.'

Trade in the Middle Ages

It used to be thought that the 'Middle Ages' were more or less a unit – and that what was true of one mediaeval century held good for another. This is not so. Mediaeval England saw many important changes, and none was more significant than the growth in trade, which, in the 12th and 13th centuries, created a giant European trading community, with goods travelling from one end of the continent to the other. In the middle of this was Flanders: the market for wine from the Rhineland and Bordeaux, iron from Spain, fish and firs from the Baltic, silks and spices from the East, and, above all, the centre of the wool trade.

England was the greatest wool-producing country in Europe, but until the 14th century she had scarcely any *cloth manufacturing* industry, and so did not use this superb wool herself. Instead she gained enormous economic wealth by exporting it. She supplied the great centres of the continental cloth industry; these were certain Italian towns like Florence, which produced very high-grade luxury cloth, and, above all, Ghent, Bruges, Ypres, and Douai in Flanders.

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The English producers

Almost every farmer in mediaeval England had his flock. Some great landowners owned vast numbers of sheep, like the Bishop of Winchester, who, in 1259, kept 29,000. For a long time Englishmen did not export the wool themselves. Instead they sold it to foreign merchants. These were predominantly Flemish in the 12th century, but by the end of the 13th century the Flemings were being ousted by the Italians. The large landowners could make individual contracts with merchants, often for years in advance. In such cases they would be paid in advance as well – a cash payment called an *arra*.

But in the case of the small farmer, the exporter had to employ agents to go around bargaining for and collecting the wool. This task was also done independently by *middlemen* who played an increasingly important role in the mediaeval economy.

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These pictures illustrate various aspects of the wool trade. ① *An ancient wool house.* ② *Flemings' houses, Kersey, Suffolk.* ③ *and* ④ *Weavers at their looms. Weavers' companies grew up all over the country, many with their own seals* ⑤. ⑥ *The wool market at Chipping Campden, a great wool centre.* ⑦ *In the 14th and 15th centuries weavers became increasingly prosperous; many were able to build themselves comfortable town houses.* ⑧ *Dyers at work.* ⑨ *The wool staplers' hall at Chipping Campden.*

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In the 12th and 13th centuries English wool products were mainly in the hands of great landowners, but in the 14th and 15th centuries the decline of feudalism meant the break-up of many of the huge estates. The result was that the small-scale producers (and at the same time the middlemen) came into their own.

Moreover, England did not remain a producer only of raw wool; in the later Middle Ages she began to weave some of her wool herself, and a native cloth industry grew up. This meant still greater prosperity for the wool producers – and for the middlemen, who could now sell their wool to home manufacturers as well as to the export merchants. Many became fabulously wealthy.

How the export system worked

Before we look at the developments concerned with the transfer of trade from foreigners to Englishmen, let us pause to examine the crux of the whole system of mediaeval buying and selling in foreign countries. Let us see, in fact, how the merchant actually, physically, got his profit. First imagine an English merchant; he would probably obtain wool either through a middleman or directly, from a number of farmers. They would want paying at once, but he, of course, would have to wait a long time before he sold it in Flanders. So, unless he had a large reserve of money, he would either give them an I O U or get a loan from one of the large (probably Italian) banking houses in London. Then he would collect his wool and ship it to Flanders. Once there he would sell it at one of the fairs or markets for as good a price as he could get. But, of course, his price would be in Flemish currency, and he would want it in pounds sterling, both for his own convenience as an Englishman, and to pay the debts he had contracted

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with the wool growers and the bank. He *could* buy gold to bring to England to pay his debts (or to sell at current prices), but shipping gold out of the country was dangerous because of robbers, and it was also illegal.

He would be more likely to go to a banking house in Flanders and buy a *bill of exchange*. This he would take to the bank in London, and get pounds sterling for it. If it was a good year there would be lots of English merchants wanting bills, and for a bill worth 20*s* sterling the banker might be able to ask as much as, say, 32*s* Flemish. In other words, the exchange rate, 20 : 32, would be high. Now our merchant crosses the Channel, and takes his bill to a London banking house. Unfortunately for him (in a good year) there are lots of merchants with similar bills, and every bill worth 20*s* at the Flanders exchange rate the London banker may be able to buy for only 18*s*. In other words, the exchange rate can go higher still (18:32). So you can see from this that the exchange rate fluctuated, and that the merchant only knew his final profit after the final bill had been cashed. Sometimes, of course, the exchange rate lowered, and he made an unexpectedly large profit. Perhaps it is worth remarking that the high exchange rate was usually favourable to England, insofar as her pound sterling was worth a lot of Flemish money. It was only because the English merchants happened to have Flemish currency that the rate would work against them.

Wool taxation

Mediaeval kings were always on the lookout for new sources of revenue. There were two ways in which the king could profit from the wool trade: he could either levy a tax *in* wool or *on* wool. The first meant that he literally seized stocks of wool from his subjects, and sold them himself. This was naturally only an emergency measure. The second method was a wool custom, or export tax. Although the levy of customs was a royal prerogative, its collection depended on the co-operation of those who were taxed, and so the king had to negotiate with the merchants. These would meet as a distinct body – The Assembly of Merchants – to treat with the king. The king would often convene the Commons at the same time and for the same purpose. Strangely, it was from them rather than from the Assembly of Merchants that he met with opposition. This was because a tax, unless it was particularly exorbitant, did not seriously affect the merchants; they could simply charge continental buyers more, and pay English farmers less for the wool. The House of Commons was only just beginning to become important at this time, but on several occasions it opposed the king over the levying of a wool tax, and this had a great effect on its growing sense of independence and unity.

The first specific export tax on wool, which became known as the 'great and ancient custom', was levied in 1275; it

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was the only one which never aroused any opposition. In 1294 and 1297 Edward I, desperate for money for his war with France (see page 2590), levied a huge wool tax – 40*s* per sack. This unpopular levy became known as the *maltote*.

Preparations for the Hundred Years War again put the king in urgent need of money. In 1336 a 40*s* maltote was accompanied by a fixed price schedule. This was intended to protect the growers from the low prices that the export merchants were in the habit of paying to escape shouldering the tax themselves. It was the beginning of a compromise; up till then the Commons had opposed the maltote outright; they now agreed to it so long as they could control it. In 1340 they granted it for one year only.

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The staple

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In the 14th century the king began to realise that he would make a much greater profit from the export of wool if he could direct it all to one place and tax it on the spot as it passed through. In this way the *staple* system grew up. A staple town was simply one through which the exported wool had to pass – the first, in 1313, was St Omer. But the location of the staple was constantly changing; sometimes an English town was found more convenient, and it was only at the end of the century that Calais (an English town but on the continent) was finally settled on.

At the same time the wealthiest English merchants had gradually been replacing the Italians as royal financiers. As such they had been allowed certain trading privileges, and had established a virtual monopoly of the export trade. The king realised that by making the English monopoly official, and giving English merchants the right to manage the staple, he could turn it to his advantage. And so the Company of Merchants of the Staple was born. In return for their monopoly in handling the staple trade, they had to pay heavy subsidies to the king. In 1466 the Act of Retainer gave the Company the right to all wool profits, in return for which it had to pay the wages of the garrison at Calais.

Cloth takes over

The most important effect of the staple monopoly was that it lowered the price of wool in England. For the staplers, who had to pay heavy subsidies to the king, could not also pay high prices to the wool producers. This greatly stimulated the native cloth industry; English manufacturers could now produce cloth far more cheaply than those abroad, who had to pay more for the same raw material. And so, from the early 15th century onwards, although figures for wool export declined, those for the export of cloth soared, and sheep farming became more profitable than ever.

YOU SHOULD NOW KNOW

1. *Which country was the centre of the mediaeval wool trade?*
2. *Who were the middlemen?*
3. *What was a bill of exchange?*
4. *Where did the 'staple' settle?*

⑨

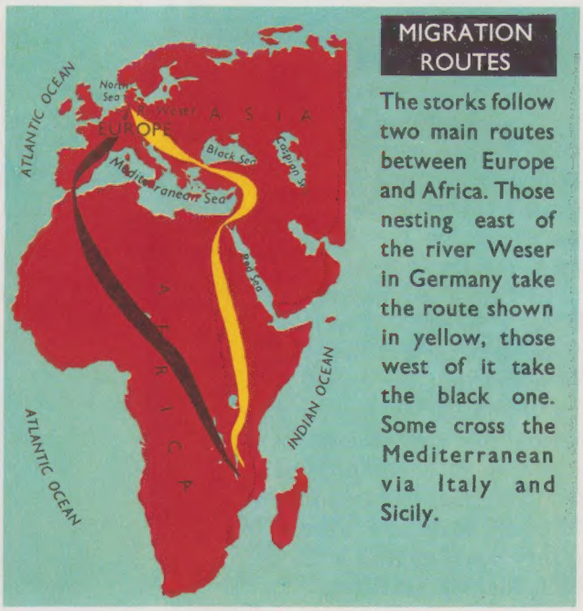
THE STORK

YOU may notice when travelling in Holland, Belgium, Germany, or France that some of the houses have cartwheels or round platforms laid on the roofs, but you may not be able to guess what they are for. People put them there for white storks to nest on, as it is considered very lucky to have a pair of these great birds living on the roof of your house. At one time, before men started building houses, they no doubt nested in trees like most other kinds of storks, but for many hundreds of years they have accepted the hospitality of householders in Europe, and now almost always make their nests on buildings.

There are records of the white stork (*Ciconia ciconia*) nesting in Britain in mediaeval times, but it has long ceased to do so, and now comes only as a rare wanderer.

A pair of white storks, with their young, on a nest on the roof of a house. The nest is built on a cartwheel, put there specially to attract the birds

A journey of over 6,000 miles
When they reach their nesting sites in March and April the storks can be excused if they take a rest, for they have just completed a journey of over 6,000 miles. They have, in fact, passed the winter in the southern part of central Africa, in the region of the great lakes, and they will set off again in August for their winter home. They prefer nesting in districts like northern Europe, where there are marshes and canals, because they can find plenty of food in such places.



MIGRATION ROUTES

The storks follow two main routes between Europe and Africa. Those nesting east of the river Weser in Germany take the route shown in yellow, those west of it take the black one. Some cross the Mediterranean via Italy and Sicily.

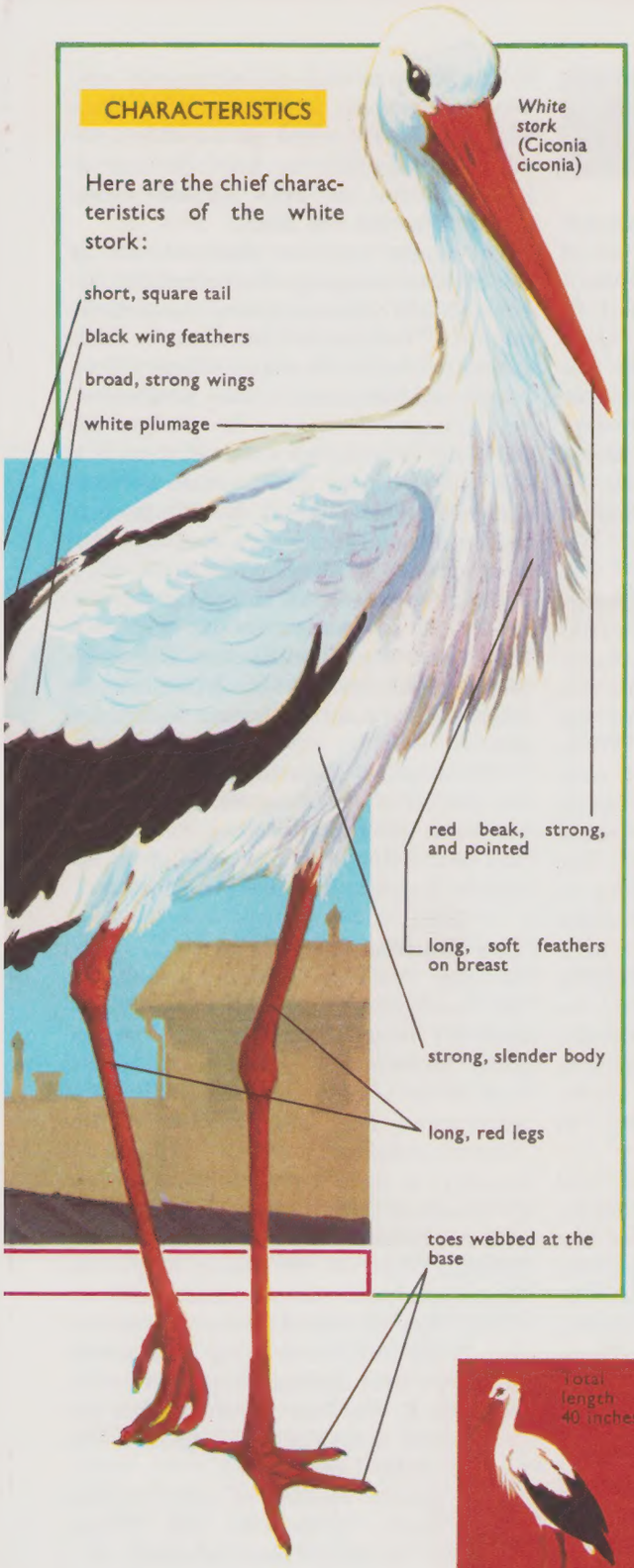
A huge nest

The same pair of storks may remain together for years, returning, season after season, to the same nest. Soon after they arrive, they repair the damage done by the winter storms and add new material to it. Branches and sticks are used to build the nest, with lumps of earth and grass to give it weight; the nest is usually lined with grass, and often bits of paper and rag that the birds pick up around the houses are also used. The male collects most of the material and the female arranges it. Some old nests, added to year after year, may be 6 feet across, 6 feet high, and weigh several hundredweight.

Storks are excellent parents; both take a share in incubating the eggs. They feed their young for seven or eight weeks in the nest, and for a further two or three weeks after they can fly.

CHARACTERISTICS

Here are the chief characteristics of the white stork:



How they live

Storks are sociable birds. Several pairs often nest close together, and they frequently hunt for their food in small groups. When they are on migration flight, and when they are in their winter quarters in Africa, they gather in huge flocks. They fly powerfully with slow wing beats, and, when on the ground, their gait is a sedate walk.

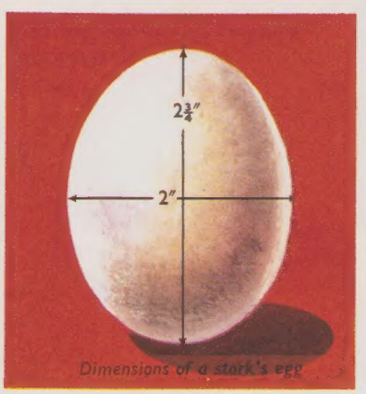
They feed largely on frogs, fish, small reptiles, and insects, but will eat any small creature living on the ground or in the water. In Africa they are considered useful because they destroy harmful grasshoppers and locusts. The young are fed on partly digested food which is regurgitated onto the nest.

The young birds make mewing noises when calling for food, but the adults have no voice at all. They can make a loud noise, however, by clattering the mandibles of their beaks together, and they communicate with each other by this means and by elaborate posturing. When one returns to the nest where its mate is incubating, they both throw back their heads until the crowns touch their backs and clatter their beaks in greeting. For a moment it looks as if both birds' necks are broken.

When they are out in the fields, storks are shy and difficult to approach, but when at their nests they behave almost as if domesticated.

THE BLACK STORK

The only other kind of stork found in Europe is the black stork (*Ciconia nigra*). It is a little smaller than the white stork, and its plumage is black everywhere except on the underparts behind the throat. It does not live near man, but is shy and solitary, nesting in trees in forested country. The black stork lives in Asia and eastern Europe, and also in Spain. It is a very rare visitor to Britain. Like the white stork, it migrates to southern Africa for the winter.



Appearance of the two species in flight; note outstretched necks and legs

CLASSIFICATION

Storks are placed, together with herons, ibises, and spoonbills, in the Order Ciconiiformes; the various kinds of storks make up the Family Ciconiidae. They differ from herons in flying with both neck and legs outstretched, and in being voiceless.

SIR ROBERT PEEL

Sir Robert Peel (1788–1850)

'FOR between 40 and 50 years, the right honourable gentleman has traded on the ideas of others. His life has been one great appropriation clause. . . . There has been no statesman who has committed petty larceny on such a scale.'

The 'right honourable gentleman' referred to in this scathing denunciation was none other than the British Prime Minister, Sir Robert Peel; and, moreover, it was delivered by a member of his own party – Benjamin Disraeli. Disraeli loathed Peel, describing him as a 'burglar of other men's intellects'.

Were these attacks justified? Was Peel completely unoriginal and capable only of taking his policies from others? In a sense, we would probably have to answer 'yes' to both these questions. Yet it is a great, not a small, mind that can change its opinions in the face of a sound argument. A far more just comment on Peel is that of Lord Rosebery: 'the model of all Prime Ministers.'

Peel was born the son of a wealthy industrialist on 5th February 1788, and entered Parliament at the age of 21. He soon attracted attention as a fluent speaker and a master of detail. Within a year of entering Parliament he became Under Secretary for War and the Colonies. Two years later he was appointed to the important post of Secretary for Ireland. His Irish policy was by no means progressive, and was largely unsuccessful. He advocated strong, coercive measures to quell the rebellious Irish. He was opposed to Catholic Emancipation – that is, giving the Catholics the vote and other rights. Yet he did try to apply his measures justly, and earned himself a growing reputation as a young Tory of promise. In 1819 he became chairman of a secret committee which reported in favour of the resumption of cash payments by the Bank of England. He was bitterly attacked by the landowners for betraying his party's traditional supporters. They had contracted large debts in paper currency when its value was deflated. Peel, in effect, was telling them to pay their debts in gold.

'Bobbies', and the Criminal Code

In 1822 the Prime Minister, Lord Liverpool, invited Peel to become Home Secretary – an appointment which proved one of the most important events in the history of modern criminal law. When Peel became Home Secretary there were over 200 offences which carried the death penalty. They ranged from high treason to 'damaging Westminster Bridge'. The result was that juries were failing to convict people of minor offences for which they might be hanged. Peel, influenced strongly by such reformers as Romilly and Mackintosh, drastically reduced the number of capital offences, and, equally important, established the Metropolitan Police Force. Policemen have been known as 'bobbies' or 'peelers' ever since, in honour of their founder.

In 1827 Lord Liverpool died, and George Canning became Prime Minister. Peel, together with his great friend the Duke of Wellington, refused to serve under Canning because he supported Catholic Emancipation. But the same year Canning died, and Wellington became Prime Minister with Peel as Home Secretary. At once he had to meet a crisis in Ireland. In 1828 the Catholic leader Daniel O'Connell was elected as Member of Parliament for County Clare. As a Catholic he was not legally allowed to take his seat. Civil war with Ireland was near, and Peel and Wellington decided that, in the national interest, they must abandon their policy. The Catholic Emancipation Bill became law in the middle of April 1829.

By now the greatest political issue was that of Parliamentary reform. Peel and Wellington were against reform, and in the election of 1830 the Whigs were returned with a large majority. The Great Reform Bill was passed in 1832, and Peel and the Tories had to adjust themselves to a new era in British politics.

The Whigs proved administratively very weak, and were unpopular with King William IV. He seized on a half-hearted offer of resignation by Lord Melbourne in 1834, and so Peel became Prime Minister for the first time.

Parliament was then dissolved, and in the election campaign Peel stood for the borough of Tamworth where he issued the famous 'Tamworth Manifesto'. This sought to abolish the old reactionary Tory image and substitute a more progressive, yet 'Conservative', one. He pledged his party not to undo the Great Reform Bill, but not to extend the franchise any further. After the election the Whigs were still in a majority, though Peel was able to continue in office until April 1835. During this time he impressed Parliament and the nation by his skill as a leader and a parliamentarian. Then, defeated decisively on an Irish bill, he resigned, and Lord Melbourne returned to power.

The ensuing years in which Peel was out of office were not wasted. He remained the most influential man in Parliament, and united his party under a tighter discipline than any political party before.

The 'Bedchamber Crisis'

In 1839 Peel was suddenly thrust into the limelight in one of the most extraordinary incidents of the 19th century. Lord Melbourne resigned when he felt that he no longer had the confidence of Parliament. Peel was asked by Queen Victoria (who had succeeded William IV in 1837) to form a government. Perhaps Peel realised that it was Lord Melbourne, and not himself, who really had her confidence. Whatever the reason, he put the Queen in a most awkward position by insisting that she should remove many of her Whig ladies-in-waiting and substitute Tory ones instead. Not unnaturally, she refused. Peel had to wait another two years before the era of the Whigs gave way to that of the Tories.

The general election of 1841 resulted in a heavy defeat for the Whigs, and Peel became Prime Minister at a black and menacing period in British history.

The Whigs had been completely inept at dealing with the nation's economy. There was a vast deficit in the budget, a terrible slump in trade and industry, and an appalling unemployment rate. In Manchester alone 8,666 people earned less than 1*s* 2½*d* a week – at a time when bread cost about 1*s* a loaf, and other food prices were almost equally high.

It is not surprising that the nation was seething with discontent. The 'Char-

tists' clamoured for reforms which would have swept the lower classes to power. The Anti-Corn Law League, led by Richard Cobden and John Bright, campaigned loudly for 'cheap bread'.

Yet little could be done while the government remained bankrupt. Peel himself summed up the situation in 1841: 'Can there be a more lamentable picture than that of a Chancellor of the Exchequer seated on an empty chest, by the pool of bottomless deficiency, fishing for a budget?'

The economic crisis needed a master hand, and, in dealing with it, Peel proved himself one of the ablest of all British statesmen.

Peel himself introduced his memorable budget of 1842 which imposed an income tax of 7*d* in the pound. The revenue from this was offset by wholesale tariff reductions to reduce prices. Export duties on British manufactures were abolished, and duties on many imports reduced. The policy of freeing trade continued in all his subsequent budgets, and the results were startling. Trade improved, business 'boomed', prices fell, and jobs became plentiful. In 1844 Peel was able to announce a budget surplus of over £2,000,000 – compared with a deficit of the same amount two years earlier. In 1844 he passed the famous Bank Charter Act which increased the confidence of the nation by prohibiting new, unstable banks from springing up and issuing notes.

Irish disaster

It is one of the tragedies of politics that Peel's astonishing achievements were cut short by a sudden and terrible natural calamity. For, in August 1845, the first rumours reached England of an impending disaster in the Irish potato crop. By autumn the worst suspicions were confirmed. Soon hundreds of thousands of Irishmen were starving to death. Many more were emigrating. Something had to be done.

Peel had long ceased to believe in the Corn Law – a sliding scale of duties which kept the price of corn high. In 1842 he had reduced the duties. Shortly afterwards he heard a speech by Cobden in favour of abolishing them. Turning to a colleague, he said: 'You answer this, for I cannot.' Yet the Corn Law was regarded by many Tories as an essential part of their policy, and necessary for the prosperity of the landowners. In December 1845 Peel resigned, but the Whig leader, Lord John Russell, could not form a ministry. The same month Peel returned to office; Disraeli remarking with grim malice: 'Lord Russell declined with courtesy, and handed back the poisoned chalice to Sir Robert.'

In 1845 *Peel aroused great hostility by increasing the government grant to the Catholic seminary for priests in Maynooth. Here is a* Punch *cartoon for that year showing him, with his many policies, as a 'one-man band'*

Peel introduced his bill to abolish the Corn Law in January 1846. The bulk of his party turned against him. A combination of 'Peelites' and Whigs got the bill through the Commons on 15th May and the Lords on 25th June. It was the end of Peel's ministerial career, for, on the very same night as the Lords passed his Corn Law Bill, the 'protectionist' Tories got their revenge. Peel was defeated on a Life Protection Bill and resigned. Disraeli wrote: 'As the Protectionists passed in defile before the Minister to the hostile lobby, it was impossible that he could have marked them without emotion: the flower of that great party which had once been so proud to follow one who had been so proud to lead them . . . They trouped on . . . Sir Robert looked very grave . . . He began to comprehend his position, and that the Emperor was without an army.'

The Tories were shattered, and it was 20 years before they were once more able to challenge the Whigs. Peel himself, with a small band of 'Peelites', played an influential role in the next few years. In fact Peel was still in the prime of life when, on 29th June 1850, he was thrown from his horse while riding. On 2nd July he died. That night working men were seen crying in the streets. The man who had destroyed his career to make bread cheap was dead.

Whether the things he did were original or not does not matter very much. His life's work is a good enough epitaph. He gave British justice a new reputation; he gave Catholics their civil rights; he gave the Conservative Party its image; he rescued the nation from bankruptcy and possible civil war; he repealed an outdated law even at immense cost to his own career and his party's future. Even Disraeli was not all condemnation. He called Peel 'the greatest Member of Parliament that ever lived'.

YOU SHOULD NOW KNOW

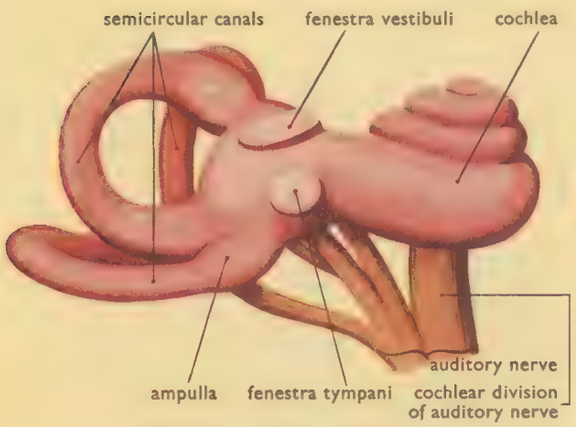
1. *When did Peel become Home Secretary?*
2. *Why did he oppose Canning?*
3. *What was the Bedchamber Crisis?*
4. *How did Peel improve British economy?*
5. *How did Peel split his party?*

29th June 1850 – *Peel is fatally injured*

HEARING

IN 1739 a war broke out between England and Spain because a certain Captain Jenkins had had his ear cut off by the Spaniards. He probably looked rather strange, but it is unlikely that his hearing was seriously affected. The external parts of the ears, the *auricles*, are of very little importance in human hearing. The significant parts lie deep in the head, embedded in the temporal bone, and, in consequence, are wonderfully protected from injury.

Those parts of the ear which are visible, the auricle and the *external auditory meatus*, are known as the 'external ear'. Their task is to conduct sound waves to the *ear-drum*. The 'middle ear' is the tiny chamber next to the ear-drum which contains the three minute bones of the ear, the *ossicles*. The 'inner ear' is the part in the cavity deepest in the bone. The cavity is so complex in shape that it is called the *bony labyrinth*. It consists of the central

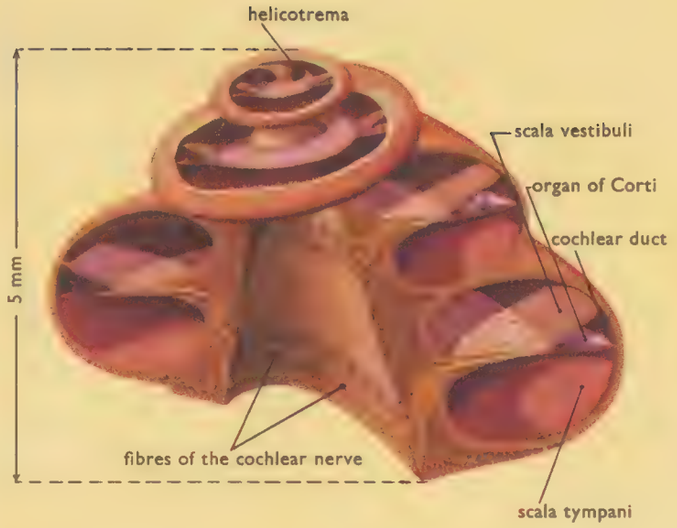


This diagram illustrates the way in which the parts of the right bony labyrinth are arranged

vestibule, the *semicircular canals*, and the *cochlea*. It is lined throughout by a membrane which, if it could be removed intact, would look like the figure in the above illustration.

Inside the bony labyrinth there lies an even more complicated membranous sac. It is the *membranous labyrinth*. Its various parts are called ducts, and there is one to occupy each semicircular canal, and another, the *cochlear duct*, to occupy part of the space in the cochlea.

The small space between the wall of the bony labyrinth and the wall of the membranous labyrinth is filled with fluid called *perilymph*. The space within the membranous labyrinth is filled with *endolymph*.

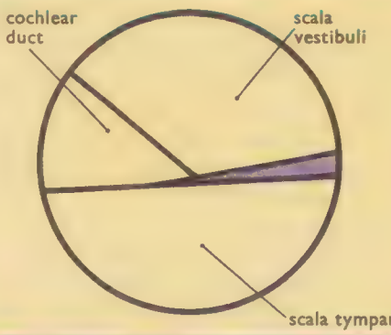


A 'cut-away' illustration to show the arrangement of the cochlea

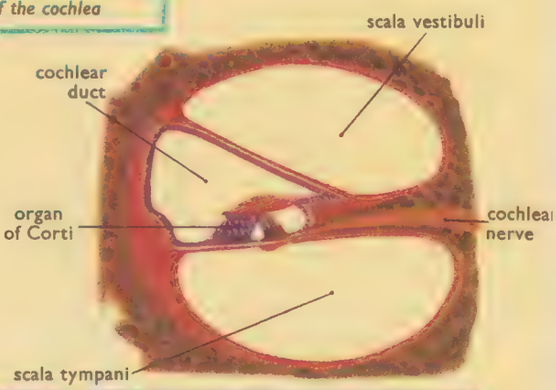
THE COCHLEA

The cochlea is shaped like a small snail. It is the part of the ear which contains the organ sensitive to sound waves.

The central axis of the cochlea is called the *modiolus*. From this structure a delicate bony 'shelf', called the *osseus spiral lamina*, projects into the canal of the cochlea and continues throughout its length. Fibres of the cochlear nerve run from the modiolus through the centre of the lamina. Attached to the osseus spiral lamina of the cochlea



A diagram of one spiral of the cochlea



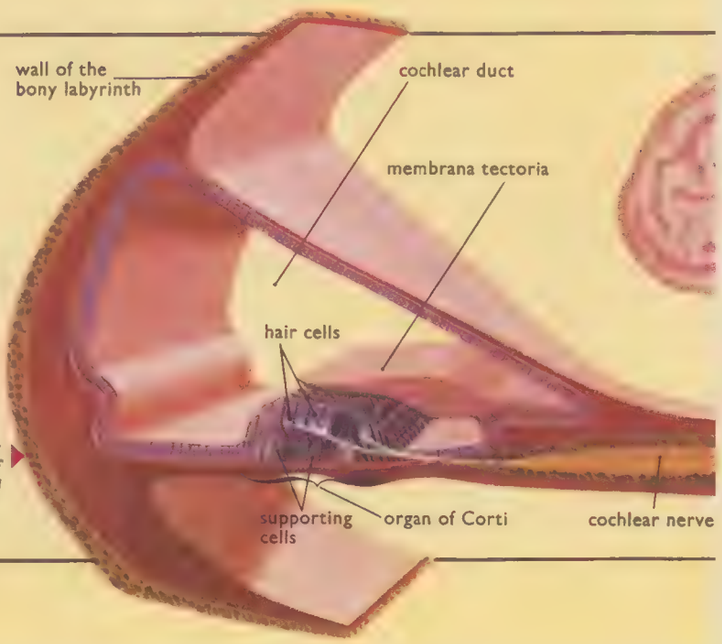
One spiral of the cochlea

are two delicate membranes. The lower of these, the *basilar membrane*, stretches from the free edge of the lamina to the outer wall of the cochlear canal. The upper membrane, the *vestibular membrane*, springs from the lamina a little nearer to the modiolus and is attached to the wall of the cochlear canal a little above the basilar membrane. In this way the cochlear canal is divided into three: the *scala vestibuli* above, the *cochlear duct* in the middle, and the *scala tympani* below. The cavities of the scalae vestibuli and tympani are connected at the top of the cochlea by a minute hole called the *helicotrema*. The cochlear duct is part of the membranous labyrinth.

THE ORGAN OF CORTI

In the organ of Corti, sound vibrations which pass along the cochlear duct are converted into nerve impulses. These impulses are transmitted along the cochlear nerve to the brain, where they are appreciated as sound.

The organ of Corti lies on the basilar membrane



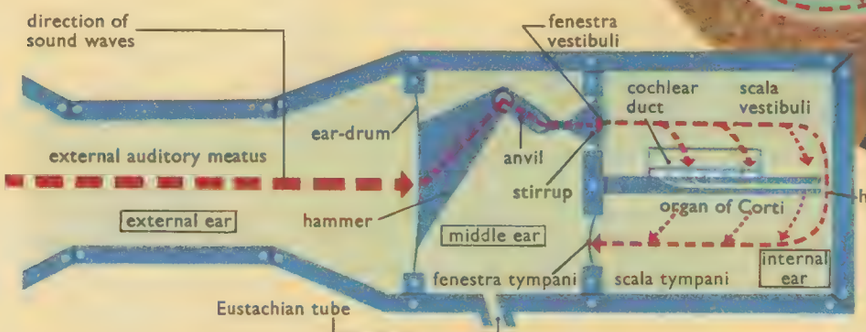
This greatly enlarged sectional view shows the way in which the parts of the organ of Corti are arranged within the cochlear duct

HOW WE HEAR

Sound consists of waves of compression and refraction in the air. The *intensity* of the sound depends on the size of the waves, and the *pitch* depends on their frequency, or closeness together.

When sound waves reach the ear they pass down the auditory canal to reach the ear-drum, or *tympanic membrane*. The sound waves vibrate the ear-drum and the vibrations are transmitted to the handle of the small bone in the middle ear known as the hammer (*malleus*). From the head of the hammer the vibrations pass to the anvil (*incus*) and then to the stirrup (*stapes*). The 'sole plate' of this last bone fits across the small aperture in the wall of the bony labyrinth known as the *fenestra vestibuli*. The vibrations of the stapes thus pass through this aperture, along the fluid in the scala vestibuli, through the helicotrema and down the scala tympani to be dissipated through the *fenestra tympani*.

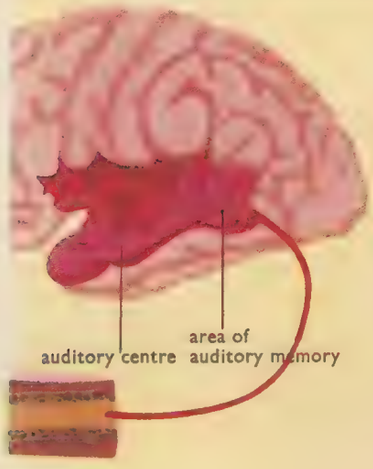
This illustration shows the way in which the external, middle, and inner ears are arranged



A diagrammatic representation of the parts of the ear

As the vibrations pass along the perilymph of the scala vestibuli they are transmitted to the endolymph in the cochlear duct and thus to the basilar membrane. It is thought that high-pitched sounds cause resonance of the basilar membrane at the bottom of the cochlea, and that sounds of lower pitch cause resonance in places correspondingly nearer to the helicotrema. The vibrations of a part of the basilar membrane shake the hair cells in the adjacent parts of the organ of Corti; this causes them to emit nerve impulses which pass along the cochlear division of the auditory nerve to the brain.

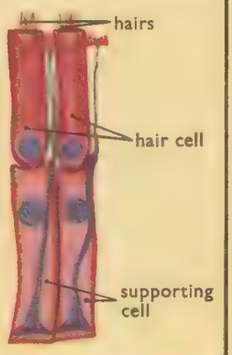
In the illustrations above, one natural and one diagrammatic, the dotted red lines show the route along which sound vibrations are carried from the external auditory meatus to the organ of Corti.



close to the attachment to the osseus lamina. In this situation it extends throughout the whole of the two three-quarter turns of the cochlear duct.

Basically the organ of Corti consists of two rows of rod cells which are arranged on the membrane to form a minute arch. To this arch are fixed four rows of hair cells, one row on the inner side and three on the outer. On both sides of the arch the hair cells are held firmly in position by rows of *supporting* cells. The *membrana tectoria* arches over the whole of the organ.

At the upper and free end of each hair cell a small number of acoustic hairs project into the cochlear duct. To each cell a minute fibre of cochlear nerve is attached.



Two hair cells and two supporting cells shown as they are arranged in the organ of Corti

SOUND APPRECIATION

The fibres of the cochlear nerve are connected to the cortex of the *auditory centre* in the *superior temporal gyrus*. Each fibre of the nerve serves only a short length of the organ of Corti, and is provided with its own particular area on the auditory cortex. Consequently a pure note, which causes vibration of only a few hair cells, is responsible for the excitation of only a small, though exclusive, area of cortex. It is this association of each part of the organ of Corti with a particular area of the auditory cortex which makes possible the recognition of sounds of different pitch.

The areas of temporal cortex adjacent to the superior temporal gyrus are concerned with the memory of sounds and their association with the other senses and the emotions.

THE SPANISH CIVIL WAR

Another Spanish city falls to the rebels. Falangists raise their flag in triumph and give the Fascist salute

IF you ever go to Spain you will find that many of the people bear the marks and scars of war wounds – this is because nearly 30 years ago there occurred in Spain one of the most terrible civil wars in European history. It was the first time in Europe that modern methods of warfare were used; and, occurring as it did in one of the most primitive countries in Europe, its effects were shattering. But this war was more than just a conflict between rival Spanish factions. It had a world-wide significance.

The years between the world wars saw the growth of rival ideologies – Democracy, Communism, and Fascism. In the 1930s the world became divided into bitterly hostile camps. The rise of the Fascist Hitler heightened international tension. Early in 1936 Hitler defied the League of Nations and re-militarised the Rhineland. France, frightened by the League's powerlessness and Hitler's belligerence, signed a defensive alliance with Communist Russia. This in turn provoked the Fascists; and Mussolini, the Italian Fascist leader, took the might of the Italian army against a helpless Abyssinia. In July of that year the Spanish Civil War broke out, and at once became the focal point of a divided world. The Fascist powers helped the Fascist party in Spain; the Communist states and Democracies supported the anti-Fascist party called the Republicans. At any time the Civil War could have developed into a major world war. As it was, it resembled 'a little world war', fought at great cost and entirely on Spanish soil, and it provided a rehearsal for the tragic events of 1939–1945.

Before it Spain was poor, primitive, and divided between a host of different parties. Areas like the Basque provinces and Catalonia wanted to be independent. Above all, Spain was suffering from misgovernment.

After the First World War there had been a long succession of unsuccessful governments. The left-wing party, which ruled from 1931 to 1933, proved unpopular and inefficient. It granted a Statute of Autonomy (granting partial self-government) to Catalonia which was resented by those who supported a united Spain. A right-wing government ruled from 1933 to 1935, and revolts and outrages against this government spread up and down the country. The Catalan 'separatists' demanded increased rights, and the government cruelly repressed them. Outrages and murders went on all over Spain, and at the end of 1935 the President resigned. In February 1936 a Popular Front government came to power, electing Manuel Azaña y Díaz as President. He was supported by all the left-wing groups – Communists, Socialists, and many others. This was the signal for complete chaos. The peasants seized the land and defied all efforts to eject them; churches and monasteries were burned; rich men were killed and their houses ransacked; gangs of robbers and murderers roamed the country; and in the first four months alone of the Popular Front government there were 113 general strikes.

It is no wonder that there was a right-wing reaction against

General Franco at the battle-front

such lawlessness. The Fascist (known as the 'Falangist') party gained many supporters as advocates of the dictatorial measures. On July 17th an armed revolt broke out in Spanish Morocco, led by General Francisco Franco Bahamonde. The revolt spread to the Spanish mainland, and within 48 hours the whole nation was locked in civil war.

Aid pours in

The rebels were a mixture of Falangists, 'Traditionalists', and Monarchists. Because they were violently opposed to Regionalism, they called themselves *Nationalists*. The government supporters – Socialists, Communists, and other left-wing groups – were called *Republicans*.

The rebels were immediately successful over much of northern Spain. In the south they captured Seville, Cordoba, Granada, and Cadiz. But they failed to take Barcelona or Madrid. At first the struggle looked fairly equal, for the government had control of most of the south and all of the east. But the Nationalists had control of most of the army and artillery; and the Republican troops were untrained, raw recruits. Moreover, from 1st October 1936, when General

November 1936. *Franco's men feed children during their unsuccessful march on Madrid*

Franco assumed complete command of the rebellion, the Nationalists were under a unified and capable command, while their enemies wasted much energy quarrelling among themselves.

As we have seen, Europe's attention was riveted on Spain, and foreign intervention began almost immediately. The first German aeroplanes arrived for the Nationalists as early as 28th July. The U S S R gave the Republicans 12,145,000 roubles, and further help came from the United States and Mexico. Foreigners poured into Spain. By the spring of 1937 there were about 2,000 Russian volunteers serving in the Republican Army. But this was nothing like the help given by the Fascists who lent massive support to Franco. By early 1937 there were no fewer than 10,000 Germans and 70,000 Italians in the Nationalist army.

The dangers of a world war breaking out were obviously great, and a Non-Intervention Committee was set up in London. But its efforts proved vain, while the League of Nations, despite repeated entreaties by the Republicans, remained inactive.

By mid-August Nationalist forces in the north and south had linked, though an advance on Madrid was beaten off. Nevertheless the threat was serious enough for the government, under the leadership of Francisco Caballero, to move from Madrid to Valencia.

Little progress was made by either side in the winter of 1936–1937, but in the spring of 1937 a new Nationalist offensive began in the north. In June, Bilbao, the Basque capital, fell. One of Spain's two self-governing regions had fallen to the Nationalists.

In January 1938 the Republicans gained their only real success when they captured the important city of Teruel in Aragon. But in the spring the Nationalists penetrated into Catalonia and captured Lérida. In the south they reached the Mediterranean, and cut a corridor through Spain; this divided the Republican forces in the centre and south from their few remaining strongholds in the north.

By the winter of 1938–1939 the Republicans were in a terrible plight. The territories they controlled were devastated, and the people were starving. In addition, they had to clothe and feed, however inadequately, no fewer than 3 million refugees who had found their way from Nationalist lands. In December 1938 the Nationalists began their last great offensive: its direction Catalonia, its objective Barcelona. The city fell on 26th January 1939. The government, now under Juan Negrin, fled to Figueras, where it continued to hurl defiance at its enemies. Soon all Catalonia was overrun, and refugees passed in their hundreds of thousands out of Spain and into France. In February President Azaña, long only a figurehead, resigned.

There remained Madrid; but not for long. The people were starving. The daily food ration was 2 ounces. There was no heating in the city. On 28th March 200,000 Nationalists marched unopposed into Madrid, and two days later came the final surrender. War had lasted 984 days, and had cost a million lives.

A horrified Europe

After the horrors of the Second World War, with its refugees, displaced persons, extermination camps, and air-raids, it is hard to appreciate the revulsion felt throughout Europe at the atrocities in Spain. The war itself was conducted with almost inhuman savagery. Private revenge and murder were everyday occurrences. Republican supporters, whose government abolished public worship in its territories, murdered 10 bishops and many thousands of priests in cold blood. At the same time the Nationalists ordered mass executions and took terrible reprisals on Republicans who fell into their hands. The Spanish Civil War saw the first large-scale air-raids which provided welcome practice for the planes of Germany's *Luftwaffe*. Seven hundred people died in one air-raid on Granollers – a terrifying figure to a world totally unaccustomed to the bombing of civilian populations.

The Spanish Civil War was one of the most horrible of all civil wars. Yet its results, compared with so many other Spanish revolts, have proved strangely durable. For General Franco, who began that revolt in Morocco over 30 years ago, remains the ruler of Spain to this day.

1936 – *Nationalist troops rest in the suburbs of Madrid*

JOHN CONSTABLE

SCENERY can be just as beautiful as a human face or human body. Yet for centuries, in England and in the rest of Europe, landscapes were ignored, and even despised, as subjects for painting. In the Middle Ages, if views were painted at all, they were pushed right to the back of a picture to act as a kind of decorative backcloth to the figures, which were the real point of the picture. Such landscapes made no attempt to be realistic; they were always on one plane, very flat, and with no perspective. The idea that human beings were the only things worth painting persisted for centuries. It was not until the 18th century that artists began to paint landscapes for their own sake. But this growth of interest in the natural beauties of the countryside was not peculiar to artists; the landscape school which suddenly blossomed in the 18th century was the beginnings of a much larger Romantic movement which reached its climax with both Wordsworth (see page 2352) in literature and Constable in painting. This may in part have been a reaction against growing industrialisation; men only began to value their countryside when they saw it in danger of being swamped by factory chimneys and sprawling suburbs. But in painting at least it was first and foremost a revulsion against the formal, restricted style of the fashionable painting of the day.

By courtesy of the Trustees, the National Gallery, London

The Haywain (1821) *shows Constable at his best as an observer of the English countryside*

Landscape painting was born in France, with Claude Lorrain and Nicholas Poussin. They painted formal and stylised classical landscapes, and had a great effect on the first great English landscape painter, Richard Wilson (1714–1782). He was followed by Thomas Gainsborough (see page 1934), John Crome (1768–1821), and others. By the time Constable started painting, early in the 19th century, sketching from nature had become a widespread pursuit. Yet Constable announced his intention to be a 'natural' painter, as something new and revolutionary; and art historians have agreed with him. We shall try to see what it is about his paintings that distinguishes them from anything that had gone before.

A Suffolk artist

John Constable was born at East Bergholt, in Suffolk, on 11th June 1776, the son of a prosperous miller. His father was anxious that Constable should enter the Church, but right from the start he was devoted to painting. He was lucky in attracting the attention of Sir George Beaumont, a keen patron of the arts, who lent him drawings by the English water-colourist Girtin, and by Claude Lorrain, to examine. In 1795 he visited London to study, but after a short time returned to help his father at the mill. It was not until 1799 that he was admitted to the Royal Academy Schools. He was already attracted to landscape painting and spent much time studying the Dutch landscape masters, Ruysdael and Rubens, and the English Gainsborough. These three were to have a tremendous effect on him throughout his life.

The year 1811 was a turning point in his life. It was then that he met, and fell in love with, Maria Bicknell. Although her family was opposed to the match, and Constable was driven to portrait painting to make money, they were married in 1816. The twelve years of his marriage were his best and most productive years. Although he spent much of his time in London, he was continually returning to his native Suffolk countryside for inspiration. His greatest paintings were based on sketches made there; these include *Flatford Mill* (1817), *The White Horse* (1819), *The Haywain* (1821), *A View on the Stour* (1822), *The Leaping Horse* (1825), *The Cornfield* (1826), and *Dedham Vale* (1828).

Today a painting by Constable brings a thrill to the most sophisticated salesroom, but in his early years he was unable to obtain even the recognition of the Royal Academy for his pictures. He had to send *The Haywain* to the Paris Salon (in 1824) for its true value to be recognised. The death of his wife in 1828 was a shock from which Constable never wholly recovered, and his election to the Royal Academy in 1829 did little to comfort him, for he felt that the honour had come too late. He died suddenly in Hampstead in March 1837.

A great country lover

Few painters have grasped so deeply the feeling of the English countryside as did Constable, whether it is in one of his beautiful studies for *The Haywain*, or the sweeping, breathless expanse of *Weymouth Bay* with its scudding clouds. His painting is strikingly sincere. He was always completely absorbed with his subject, and, like Wordsworth, almost identified himself with nature, particularly with trees and clouds. He said himself that his art could be found 'under every hedge'. He once declared that above all things he loved 'the sound of water escaping from mill dams, willows, old rotten planks,

and slimy posts and brickwork'.

Many agree that the best of Constable's work is to be seen in his sketches. For his well-known pictures like *Salisbury Cathedral* (1823) and *The Leaping Horse* he often made six or more full-sized oil sketches. It is in these that his vitality reaches its peak; the quick, inspired brush work, fluid with feeling, is alive with wonderful, luminous colour. In *Spring. East Bergholt Common*, for example, we can almost feel the freshness of the air.

His technique

Constable had a natural sense of composition, and a remarkable ability to select from a scene just the right amount of detail, and no more, to give a true impression. His landscapes are wonderfully real, but there is all the difference in the world between them and a photograph. Let us examine his technique. Constable liked best of all to work on a canvas to which he had first applied a strong, reddish-ochre base. In many of his sketches he would deliberately leave parts of this colour tone showing through between the strokes and in areas of deep shade. Many artists have used this method, but Constable, in particular, used it to give his pictures a sense of harmony and warmth; in fact, it is as if the earthiness of the landscape was showing through.

Constable was a great innovator in many ways, not least in his use of light and shade. Before his time it had been almost an unspoken rule that the light should come from either the left- or right-hand side of the picture, at an angle of 45°. But in many of his pictures Constable used overhead lighting with great effect – his trees stood in deep, luminous pools of shadow. Constable's trees are not mere photographic representations; they seem to grow out of the soil, and the very leaves themselves are full of the life-giving sap, the dew of the morning, and the raindrop of the passing shower. One trick he used to achieve this effect was to put in tiny strokes of pure flake white amongst the greens of his foliage, a practice sneered at by some of his contemporaries as 'Constable's snow'. But this ability to catch the vibrant, sparkling effects of light was perhaps his greatest technical achievement.

A revolutionary influence

Constable really *looked* at the things he painted. The old school of classical painters had painted 'typical' landscapes in their studios, and their pictures were often very different from the original views. But Constable went out into the fields and tried to capture fleeting impressions at first hand. His spontaneity and close observation of colour were to have a revolutionary effect on painting – but in France rather than in England.

By courtesy of the Trustees, the National Gallery, London

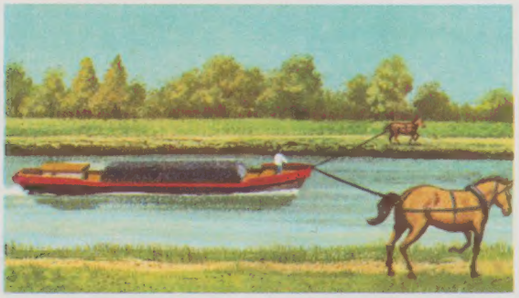
Weymouth Bay; *Constable captures the mood of the wind, sea, and open spaces*

Even during his lifetime Constable was far better received in France than in England, and after his death, and that of his great English contemporary, Turner (1775–1851), the leadership in landscape painting passed to France. Constable's influence had an immediate effect on the 'naturalistic' landscape painters of the Barbizon school like Millet, Rousseau, Corot, and Daubigny, who worked in the forest of Fontainebleau. Delacroix, the great French romantic, called Constable 'the father of *our* school of landscape', and remarked that his meadows were never painted an overall green but made up of many different shades. This was to be the secret of the Impressionists, like Monet, Pisarro, and Sisley (see page 1892), who, in their attempts to catch the shimmering effect of light, never painted solid colours. They achieved, in many ways, a greater 'truth to nature' than anyone before, and in this success they owed a great debt to John Constable.

Spring. East Bergholt Common; *Constable has caught a feeling of freshness and excitement*

Victoria and Albert Museum, London. Crown copyright

THE PARALLELOGRAM OF FORCES



A practical example of the parallelogram of forces. A barge is being pulled along a canal by two horses, one pulling with the same force as the other. The barge floats down the centre of the canal.

THINK of a toy railway wagon on its rails. We know that however hard we push on its side it will not move forward. If we push equally hard at the corner it does move forward, but not so easily as when we push directly on the end of the wagon. So we see that a force is most effective if it is applied in a direction in which motion is possible.

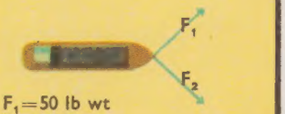
The picture above shows a barge being pulled along a canal by two horses. Because they each exert the same force the barge floats down the centre of the canal; if they pulled unequally it would move to one bank or the other. It is as if the barge were being pulled by one horse walking on the water directly in front of it. Because the two horses are not pulling along the line in which the barge is moving, their pull on the barge is less than it would be if they could walk directly ahead of it. So our 'theoretical horse' walking on the water would succeed in pulling the barge with a force less than the combined forces of the real horses.

If the two horses pulled with a force of 50 units each (a total of 100) the barge might move as if it were pulled by a force of perhaps only 70 units, some of the force exerted by the horses being lost.

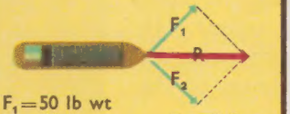
Part of each force acts at right angles to the line of motion of the barge. In this direction the pull of one horse is equal but opposite to the pull of the other, and the two pulls cancel out. This can be shown by constructing a *parallelogram of forces*.

A force can be shown as a line ending in an arrowhead. Its length represents the size of the force. The direction of the line and arrow shows the direction of the force, and the point of origin of the line with the arrowhead represents the point of application of the force.

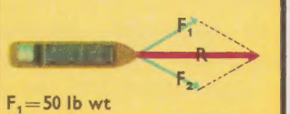
HOW TO CONSTRUCT A PARALLELOGRAM OF FORCES



Let us again think of the barge being pulled by the two horses. The point of application of the two forces is the prow of the barge, and their direction is represented by the green lines. Suppose we make a scale of 1 cm equal to 50 pounds (weight). Each line is drawn 1 cm long to represent each force.

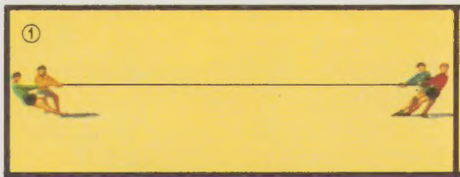


We now draw two more lines from the outer ends of the original two, each parallel to its opposite line, and form a parallelogram (a quadrilateral with opposite sides parallel). Its diagonal represents the direction and intensity of the resultant force. It measures 1·4 cm = 70 pounds on our scale.

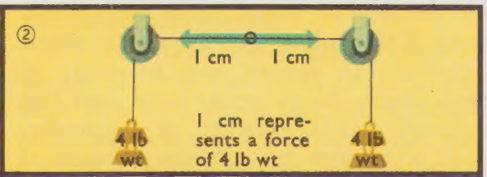


Here the directions in which the horses pull are nearer to that in which the barge is moving; this may be because the canal is narrower, or the ropes longer. It is easy to see that although the horses still pull with 50 pounds each, the size of the resultant force on the barge is greater. It measures 1·7 cm = 85 pounds.

AN INTERESTING EXPERIMENT

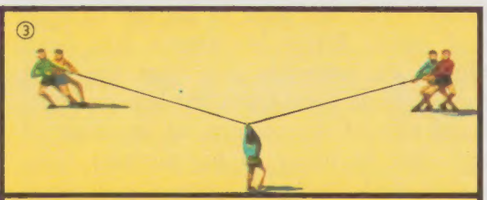


Two groups of boys are pulling on a rope with equal strength in opposite directions. The forces are balanced and neither side moves.

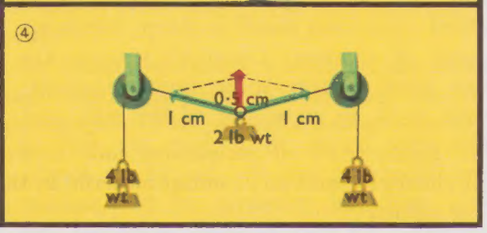


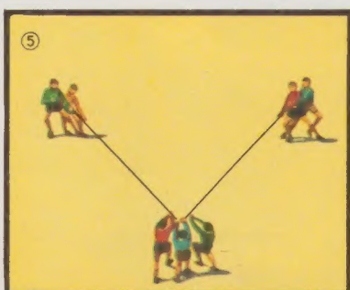
The weights attached to the ends of the string are equal, the forces are balanced, and the string between the pulleys is at rest.

Another boy comes along and grabs the rope in the middle, and the two groups of boys, one at each end of the rope, are unable to keep the rope straight. They are forced to give ground and move towards each other. They are dragged to a certain point at which the forces on the rope again balance.

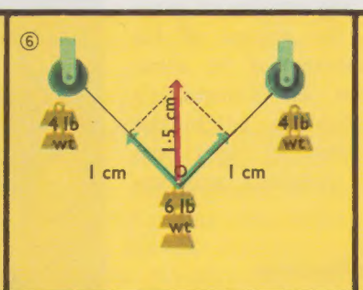


To explain this let us fix a weight of 2 pounds on to the string between the pulleys at point O. This is similar to the intervention of the newcomer in the tug-of-war. If we construct a parallelogram from the two original lines 1 cm long we find that their resultant is an upward force of 0·5 cm = 2 pounds, which exactly balances the added weight.





Two more boys join the middle one. The groups at the ends come closer to balance the forces.



The added weights at point O pull down the string farther until the forces balance again.

A fourth arrives at the middle; the end groups must join up.

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making electricity and gas, and as a valuable raw material in many new chemical processes. Many of the plastic materials and man-made fibres invented in recent years are derived from coal, while it is also possible to make oil and motor fuels from coal by special processes.

Metal working

The metals most widely used in industry are iron and steel (steel is a mixture predominantly of iron and carbon), copper, zinc, nickel, chromium, and tin. In Britain the iron and steel industry is basic – its products are used in dozens of other industries, from bridge-building to the manufacture of refrigerators. The production of iron, carried on since pre-Roman times, originally depended on the use of wood charcoal to extract the metal from the mined ore. By 1700 the woods of Sussex, the main centre of the industry, were already exhausted, but production continued in the Forest of Dean in Gloucestershire and in the north of England. The scarcity of suitable wood led to the use of coal as a heating agent, and in 1709 the process of smelting with coke was invented. By 1750 the iron smelting industry had moved to the coalmining areas of the Midlands and Yorkshire, and later to South Wales, Lancashire, Northumberland, Durham, and central Scotland.

Great technical advances in the iron and steel industry occurred in the middle of the 19th century. In 1856 Bessemer invented his converter, in which molten iron was transformed into steel by driving off impurities and adding carbon or manganese. As a result the price of steel soon fell from £40 to £5 a ton. In 1866 Siemens invented the open-hearth steel-making process, and in 1879 the first electric steel-making furnace was developed.

In spite of the basic importance of steel, and its parent iron, the metal which is most typical of our times is aluminium. Usually alloyed with harder metals, it is widely used in motor vehicles, aircraft, trains, and even ships and buildings. It is much lighter than steel but remarkably strong in relation to its weight, and is much less prone to corrosion than steel. Another metal of great industrial importance is copper. This soft, reddish-coloured metal, although not strong enough to take the place of steel, or even of aluminium alloy, is an excellent conductor of electricity and an essential material in the electrical engineering industry.

Textiles and weaving

For nearly 700 years, from the 12th century until the beginning of the 19th, wool was the most important industry in Britain, after agriculture and farming. About the year 1700 the main areas of wool production were the Cotswold country of the south Midlands, where high-grade cloth was woven; the West Riding of Yorkshire, where coarser and cheaper cloths were produced; and Norfolk and Suffolk, where foreign weavers, many of them Protestant refugees from France, had settled in the late 16th century, and wove fine woollen fabrics. For centuries the work was done in the weavers' own homes. The richer merchants provided the wool and later collected and sold the finished cloth. In the early 18th century the growth of the industry made it more difficult for the smaller merchants to obtain the raw wool, which was bought up by the richer merchants. In south Lancashire 'cotton wool' was imported from the Near East through Liverpool, but for many years the manufacture of cotton fabrics was forbidden by law because it threatened to injure the wool trade. An Act of Parliament in 1736 permitted the manufacture of cloth in which cotton was mixed with wool or linen. The damp climate of Lancashire made it easy to spin cotton, while the increase of overseas trade helped to stimulate the industry and led to inventions designed to produce cloth more cheaply and quickly. From 1733, when Kay invented the flying-shuttle loom, until 1785, when Cartwright invented the power loom, the textile industry saw many important technical advances. Outstanding among them were Hargreaves's 'spinning jenny' in 1764, Arkwright's weaving frame driven by water power in 1769, and Crompton's 'mule' in 1779. After 1815 steam power became more and more widely used in spinning and weaving. The hand-workers in their cottages fought a losing battle against the products of the new steam-powered factories, and the industry became concentrated in large towns situated on or near the coalfields.

The textile industry played a vitally important part in the industrialisation of Britain and the growth of the country's overseas trade and influence in the 19th century. The cheapness of cotton cloth, and its high value as export material, led to its becoming the most important British manufacture. In 1844 no fewer than 420,000 people were employed in this industry, less than a quarter of whom were men. This led to serious overcrowding and slum conditions in the larger towns.

Today the textile industry presents a different picture. The woollen industry, concentrated largely in the West Riding of Yorkshire, is prosperous, but the cotton industry of Lancashire has declined. Overseas markets have decreased in size, partly because the countries which formerly imported British cotton materials now manufacture their own fabrics.

Adjusting the colours of paint, one of I C I's many products

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Another factor is the immense increase in the use of man-made fibres, especially nylon and Terylene. These fibres are made by chemical processes from mineral substances such as coal and oil. They can be spun in various thicknesses and woven like cotton or linen. Threads of man-made fibres are very strong; they keep their shape better than natural fibres and need little or no ironing when used as clothing materials.

Engineering

In the modern world engineering is the key industry on which most other industries depend, and the engineer, together with the man of science, is one of the most important men in our civilisation. About the year 1800 England was the world's centre of skilled work in metal, which is the basis of practical engineering, and she became the training ground of the men who invented 'machines for making more machines'. The machine tools devised by Englishmen at that time were vitally important for their precision, their mechanical ingenuity, and the fact that they ensured the production of machines more rapidly, and therefore more cheaply, than had been possible before. By 1850 the production of machinery was on a large scale, and Britain was exporting it to all parts of the world. Without these machine tools the manufacture of railway locomotives and other types of steam engine would not have been possible. Full use of these new developments was only made when a reliable and fairly cheap quality of steel was produced about the middle of the 19th century. In 1871 a hard tool-steel was made containing tungsten and chromium, and other and later alloy steels contained manganese and nickel. In 1898 a new 'high-speed' steel for lathes enabled cutting to be done four or five times quicker than before.

Mass-production, which is essential if standard articles are to be manufactured in large quantities and sold at low prices, was established in some trades as early as 1850. Since the beginning of this century the United States has led the world in the development of mass-production engineering, and remarkable advances in the efficiency of machines and management of labour led to an increase in productivity (output of goods per man-hour) of over a third between 1920 and 1935.

The great progress made in engineering between 1880 and the beginning of the First World War, in 1914, was due to the demands of the military equipment and motor industries, which called for specialised machine tools, and interchangeable parts. New experts appeared on the industrial scene – the electrical and automobile engineers. This period saw the beginning of the typical modern factory, in which electric power replaced cumbersome shafts and belts for driving machines, and working conditions became cleaner and pleasanter.

Basic industry today

Below is a list of Britain's largest firms in terms of annual sales. These firms are all part of the basic industries of the 1960s. If any one of them collapsed it would be an economic disaster of the greatest magnitude. Not only do they employ millions of Britons, but are the backbone of the country's economy. Most of them have only become important in this century. Shell and British Petroleum have risen with the increase in the use of oil. Unilever has grown with the purchasing power of the average man, for this firm provides a vast range of goods for the consumer. British American Tobacco and the British Motor Corporation are also dependent on a market of prosperous consumers. Their main sales are respectively in cigarettes and cars. The rise of Imperial Chemical Industries is the result of the increasing use of chemicals in industry, and that of Hawker Siddeley through the importance of aeroplanes in communications and defence.

These industries either supply goods to other industries, to the consumer, or to both. The former supply *capital* goods – those which are used to make *consumer* goods or other capital goods. Capital goods may consist of plant machinery, factory equipment, and so on. Consumer goods are all the things – food, drink, clothing, furniture, sports goods and so on – that we consume or use in our everyday lives. Also important are *service* industries – these provide services like transport or catering. All these industries are *secondary* industries – in contrast to *primary* industries, like mining and agriculture, by which men obtain materials from nature.

Many of the different branches of industry are bound together. If one branch is not doing so well, it may be reflected in another. If the sales of the motor-car industry decline, then the steel industry, which provides the material for the car bodies, also declines. If there is a general economic recession, the building and engineering industry, which is involved in building new offices and factories, will suffer particularly. The standard of living of everyone in the country is largely dependent on the prosperity of industry. And the prosperity of our industry often depends on how much it can sell to other countries (export). Thus politicians abroad often try to foster their country's trade.

Another important aspect of industry today is machines doing the work of men, or *automation*. This, in many cases, hastens production and cuts costs, but carried to extremes it could also mean huge unemployment.

MAJOR BRITISH INDUSTRIAL CONCERNS

Company	1962 sales in £1,000,000				
Royal Dutch Shell	2,151	British Motor Corporation	311	Associated British Foods	183
Unilever	1,477	Tube Investments	275	Distillers Company	175
British Petroleum	718	Dunlop	269	Coats (J. & P.), Patons and Baldwins	155
Imperial Chemical Industries	579	Guest, Keen, and Nettlefold	245	Vickers	155
Hawker Siddeley	327	Associated Electrical Industries	210	British Insulated Callender's Cables	153
British American Tobacco	315	English Electric	200	Bowaters	151
		Courtaulds	185	Leyland Motors	150